phd

SERIES RA ROTARY ACTUATORS

Solutions for Factory Automation

ROTARY ACTUATOR NOMENCLATURE

2

TO ORDER SPECIFY:
Product, Series, Type, Design No., Bore Size, Angle of Rotation, and any desired Options.

SWITCH READY
E - Hall Effect magnets for Series 5360 Switch
M - Reed magnets for Series 5360 Switch
Switches must be ordered separately.

OUTPUT TYPES
Q10 - Output hub
Q19 - Output hub with hollow pinion shaft
(Available on 32 mm–50 mm units only)

BORE SIZE
20 mm (.78")
25 mm (1.0")
32 mm (1.25")
40 mm (1.5")
50 mm (2.0")

PORT CONTROL
PB - Both directions
PC - Counterclockwise
PW- Clockwise

PRODUCT
R - Rotary Actuator

TYPE
S - 150 psi (10 bar) Air Max.

R A S 1 20 x 180 – PB – NB – E – Q10

SERIES
A - Standard Duty

DESIGN NO.
1 - English
5 - Metric

ANGLE OF ROTATION
45°, 90°, 135°, 180°, 225°, 270°

CUSHION CONTROL
DB - Cushion both directions
DC - Cushion counterclockwise
DW- Cushion clockwise

SHOCK ABSORBER
NB - Shock installed both directions
NC - Shock installed counterclockwise
NW- Shock installed clockwise
GS - Shock ready both directions
GT - Shock ready counterclockwise
GU - Shock ready clockwise

Shock absorbers must be ordered separately for -GS, -GT, and -GU options. 225° and 270° units are standard shock ready.

SHOCK ABSORBER CHART

BORE SIZE	PHD SHOCK ABSORBER NO.	ACE SHOCK ABSORBER NO.
20 mm	56714-01	MC 75M-T .242-1876
25 mm	56714-02	MC 150M-T .302-1877
32 mm	56714-03	MC 225M-T .239-1878
40 mm	56714-04	MC 600M-T .685-1879
50 mm	56714-05	MC 600M-T .608-1880

SERIES RA ADVANTAGES

BENEFITS

■ Series RA Rotary Actuators are available in five sizes and six standard rotations with torques ranging to 150 in-lbs at 100 psi to cover a wide range of applications.

■ All units have zero backlash at ends of rotation for precise rotary positioning.

■ The high strength steel alloy rack and one-piece pinion shaft are designed and tested to operate for a minimum of 10 million maintenance free cycles.

■ Free floating pistons with pressure and wear compensating seals provide long life and low friction with breakaway pressures less than 5 psi (0.3 bar).

■ Oversize sealed ball bearings and large pinion shafts ensure shaft stability under heavy loading and high load stopping ability.

■ Built-in standard angle adjustments, of +10°, -45° from nominal, make it easy to adjust to specific rotation requirements. This provides a total range of actuator rotations from 0° to 280°.

■ Mounting patterns on three surfaces provide flexibility in design and unit mounting.

■ Units with rotations of 180° or less have all control adjustments and ports on top of the actuator saving space and easing accessibility.

■ Optional built-in hydraulic shock absorbers provide smooth deceleration of external loads and allow for greater load stopping capacity.

■ Optional built-in flow controls save space and provide constant and accurate control of the rotation speed.

■ Optional built-in adjustable cushions reduce end-of-rotation shock and increase the unit's stopping capacity.

■ Optional hubbed pinion shaft provides a flat mounting surface with a four bolt pattern for easy mounting of tooling and accessories to the actuator's shaft.

■ Miniature PHD Proximity Switches mount easily into slots in the actuator's body for interfacing with an electrical controller. Units can be specified for use with PHD's Miniature Reed or Hall Effect Switches.

■ Series RA Rotary Actuators are available in both metric and English versions allowing flexibility in design for a world market.
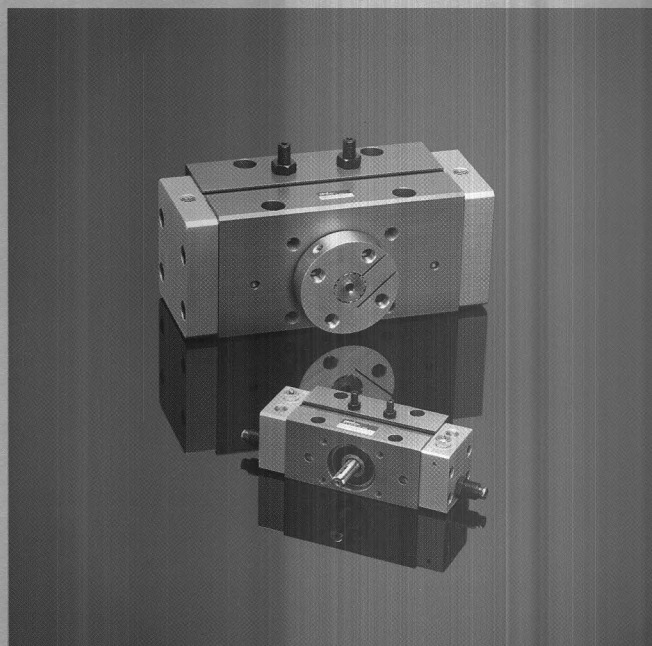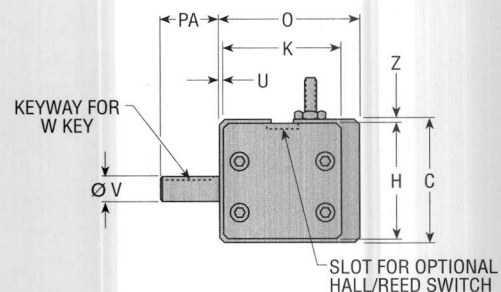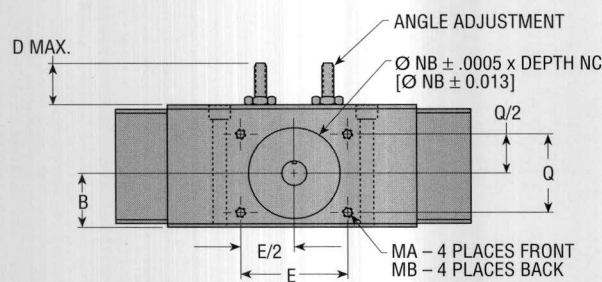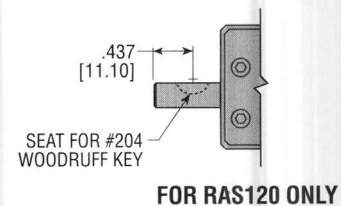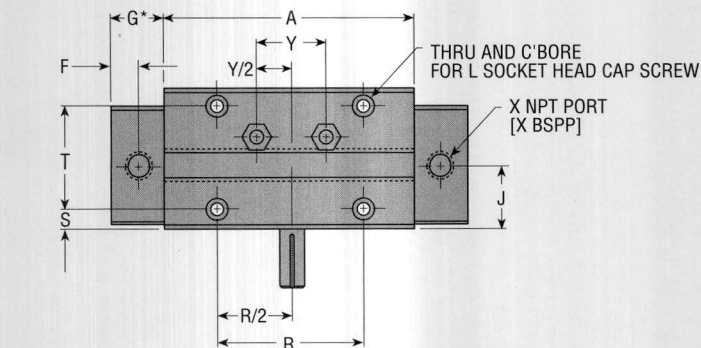
SPECIFICATIONS	20 mm-50 mm
PISTON SEALS	One Block Vee per Piston
PISTONS	Free Floating, Acetal Material
PINION SHAFTS	One Piece Alloy Steel
RACKS	Alloy Steel
END CAPS	Clear Anodized Aluminum
BODY	Hard Coated Aluminum
BEARINGS	Two Steel Ball Bearings
PORTS	NPT or BSPP
LUBRICATION	Permanent for Non-Lube Air
WORKING PRESSURE	150 psi (10 bar) Air Max.
STANDARD ROTATIONS	45°, 90°, 135°, 180°, 225°, 270°
OPTIONS	Port Controls®, Cushions, Output Hub, Shock Absorber, Magnets for Proximity Switches

SERIES RA DIMENSIONS

45°, 90°, 135°, or 180° ROTATION UNITS

THRU AND C'BORE FOR L SOCKET HEAD CAP SCREW

X NPT PORT [X BSPP]

SEAT FOR #204 WOODRUFF KEY

FOR RAS120 ONLY

ANGLE ADJUSTMENT

Ø NB ± .0005 x DEPTH NC [Ø NB ± 0.013]

MA – 4 PLACES FRONT
MB – 4 PLACES BACK

KEYWAY FOR W KEY

SLOT FOR OPTIONAL HALL/REED SWITCH

*G DIMENSION INCREASES WITH CUSHION OPTION. SEE PAGE 8.

BORE SIZE	NOMINAL ROTATION	A	B	C	D	E	F	G	H	J	K
20 mm	45° OR 90°	3.524 [89.5]	.807	1.831	.604	1.574	.394	.768	1.712	.91	1.732
	135° OR 180°	3.760 [95.0]	[20.5]	[46.5]	[15.34]	[40.0]	[10.0]	[19.5]	[43.5]	[23.0]	[44.0]
25 mm	45° OR 90°	3.819 [97.0]	.983	2.224	.724	1.772	.394	.768	2.087	1.01	1.929
	135° OR 180°	4.508 [114.5]	[25.0]	[56.5]	[18.39]	[45.0]	[10.0]	[19.5]	[53.0]	[25.5]	[49.0]
32 mm	45° OR 90°	4.606 [117.0]	1.161	2.697	.920	2.166	.394	.768	2.559	1.18	2.264
	135° OR 180°	5.650 [143.5]	[29.5]	[68.5]	[23.37]	[55.0]	[10.0]	[19.5]	[65.0]	[30.0]	[57.5]
40 mm	45° OR 90°	5.256 [133.5]	1.516	3.366	.977	2.558	.472	.945	3.228	1.57	3.071
	135° OR 180°	6.476 [164.5]	[38.5]	[85.5]	[24.82]	[65.0]	[12.0]	[24.0]	[82.0]	[39.75]	[78.0]
50 mm	45° OR 90°	6.300 [160.0]	1.674	3.918	1.191	2.952	.472	.945	3.720	1.74	3.346
	135° OR 180°	7.343 [186.5]	[42.5]	[99.5]	[30.25]	[75.0]	[12.0]	[24.0]	[94.5]	[44.25]	[85.0]

BORE SIZE	L	MA	MB	NB	NC	O	PA	Q	R	S
20 mm	#10 [M5]	10-24 x .281 [M5 x 0.8 x 7]	10-24 x .375 [M5 x 0.8 x 12.5]	1.3785 [35.014]	.085 [2.16]	2.047 [52.0]	1.000 [25.0]	1.181 [30.0]	2.166 [55.0]	.276 [7.0]
25 mm	#10 [M5]	10-24 x .285 [M5 x 0.8 x 7]	10-24 x .500 [M5 x 0.8 x 12.5]	1.4572 [37.013]	.080 [2.03]	2.362 [60.0]	1.250 [30.0]	1.378 [35.0]	2.362 [60.0]	.295 [7.5]
32 mm	1/4 [M6]	1/4-20 x .250 [M6 x 1.0 x 7.5]	1/4-20 x .500 [M6 x 1.0 x 15]	1.8509 [47.013]	.100 [2.54]	2.835 [72.0]	1.500 [40.0]	1.772 [45.0]	2.952 [75.0]	.335 [8.5]
40 mm	5/16 [M8]	5/16-18 x .437 [M8 x 1.25 x 12]	5/16-18 x .750 [M8 x 1.25 x 20]	2.0477 [52.012]	.115 [2.92]	3.544 [90.0]	1.750 [42.5]	2.164 [55.0]	3.346 [85.0]	.394 [10.0]
50 mm	3/8 [M10]	3/8-16 x .375 [M10 x 1.5 x 10]	3/8-16 x .750 [M10 x 1.5 x 20]	2.4414 [62.012]	.125 [3.17]	3.976 [101.0]	2.000 [55.0]	2.362 [60.0]	3.936 [100.0]	.452 [11.5]

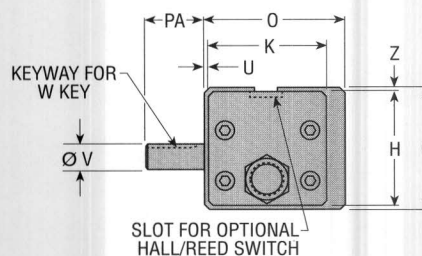| BORE SIZE	T	U	V	W KEY	X	Y	Z
20 mm	1.496 [38.0]	.04 [1.0]	.375/.374 [10 (h8)]	SEE ABOVE [3 mm SQ. x 20 mm]	1/8	1.004 [25.5]	.06 [1.5]
25 mm	1.772 [45.0]	.04 [1.0]	.4727/.4714 [12 (h8)]	1/8 SQ. x 1.125 [4 mm SQ. x 25 mm]	1/8	1.124 [28.5]	.08 [2.0]
32 mm	2.165 [55.0]	.05 [1.2]	.625/.624 [16 (h8)]	3/16 SQ. x 1.250 [5 mm SQ. x 32 mm]	1/8	1.458 [37.0]	.08 [2.0]
40 mm	2.756 [70.0]	.03 [0.8]	.750/.749 [17 (h8)]	3/16 SQ. x 1.500 [5 mm SQ. x 35 mm]	1/8	1.598 [40.6]	.08 [2.0]
50 mm	3.071 [78.0]	.07 [1.8]	.875/.874 [22 (h8)]	3/16 SQ. x 1.750 [6 mm SQ. x 45 mm]	1/4	1.984 [50.4]	.10 [2.5]

NOTES:
1) NUMBERS IN [ ] ARE FOR RAS5x UNITS (METRIC)
2) ALL METRIC DIMENSIONS ARE GIVEN IN MILLIMETERS - 1 mm = .03937 IN
3) UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE REFERENCE ONLY

SERIES RA DIMENSIONS

225° or 270° ROTATION UNITS
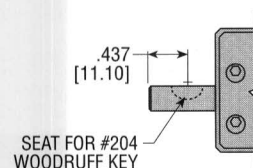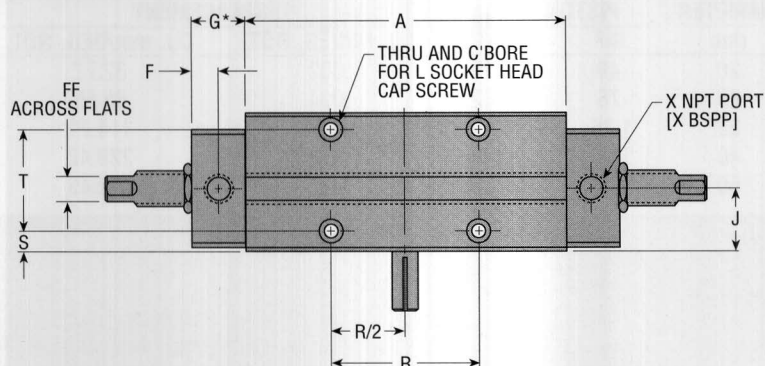
THRU AND C'BORE FOR L SOCKET HEAD CAP SCREW

X NPT PORT [X BSPP]

FF ACROSS FLATS

SEAT FOR #204 WOODRUFF KEY

FOR RAS120 ONLY

.437 [11.10]

Ø NB ± .0005 x DEPTH NC [Ø NB ± 0.013]

KEYWAY FOR W KEY

ANGLE ADJUSTMENT

MA – 4 PLACES FRONT
MB – 4 PLACES BACK

SLOT FOR OPTIONAL HALL/REED SWITCH

*G DIMENSION INCREASES WITH CUSHION OPTION. SEE PAGE 8.

BORE SIZE	NOMINAL ROTATION	A	B	C	D	E	F	G	H	J	K
20 mm	225° OR 270°	4.390 [111.5]	.807 [20.5]	1.831 [46.5]	4.39 [111.5]	1.574 [40.0]	.394 [10.0]	.768 [19.5]	1.712 [43.5]	.91 [23.0]	1.732 [44.0]
25 mm	225° OR 270°	5.295 [134.5]	.983 [25.0]	2.224 [56.5]	5.06 [128.5]	1.772 [45.0]	.394 [10.0]	.768 [19.5]	2.087 [53.0]	1.01 [25.5]	1.929 [49.0]
32 mm	225° OR 270°	6.693 [170.0]	1.161 [29.5]	2.697 [68.5]	5.87 [149.1]	2.166 [55.0]	.394 [10.0]	.768 [19.5]	2.559 [65.0]	1.18 [30.0]	2.264 [57.5]
40 mm	225° OR 270°	7.736 [196.5]	1.516 [38.5]	3.366 [85.5]	6.66 [169.1]	2.558 [65.0]	.472 [12.0]	.945 [24.0]	3.228 [82.0]	1.57 [39.75]	3.071 [78.0]
50 mm	225° OR 270°	8.917 [226.5]	1.674 [42.5]	3.918 [99.5]	7.32 [186.0]	2.952 [75.0]	.472 [12.0]	.945 [24.0]	3.720 [94.5]	1.74 [44.25]	3.346 [85.0]

BORE SIZE	L	MA	MB	NB	NC	O	PA	Q	R	S
20 mm	#10 [M5]	10-24 x .281 [M5 x 0.8 x 7]	10-24 x .375 [M5 x 0.8 x 12.5]	1.3785 [35.014]	.085 [2.16]	2.047 [52.0]	1.000 [25.0]	1.181 [30.0]	2.166 [55.0]	.276 [7.0]
25 mm	#10 [M5]	10-24 x .285 [M5 x 0.8 x 7]	10-24 x .500 [M5 x 0.8 x 12.5]	1.4572 [37.013]	.080 [2.03]	2.362 [60.0]	1.250 [30.0]	1.378 [35.0]	2.362 [60.0]	.295 [7.5]
32 mm	1/4 [M6]	1/4-20 x .250 [M6 x 1.0 x 7.5]	1/4-20 x .500 [M6 x 1.0 x 15]	1.8509 [47.013]	.100 [2.54]	2.835 [72.0]	1.500 [40.0]	1.772 [45.0]	2.952 [75.0]	.335 [8.5]
40 mm	5/16 [M8]	5/16-18 x .437 [M8 x 1.25 x 12]	5/16-18 x .750 [M8 x 1.25 x 20]	2.0477 [52.012]	.115 [2.92]	3.544 [90.0]	1.750 [42.5]	2.164 [55.0]	3.346 [85.0]	.394 [10.0]
50 mm	3/8 [M10]	3/8-16 x .375 [M10 x 1.5 x 10]	3/8-16 x .750 [M10 x 1.5 x 20]	2.4414 [62.012]	.125 [3.17]	3.976 [101.0]	2.000 [55.0]	2.362 [60.0]	3.936 [100.0]	.452 [11.5]

BORE SIZE	T	U	V	W KEY	X	Z	FF
20 mm	1.496 [38.0]	.04 [1.0]	.375/.374 [10 (h8)]	SEE ABOVE [3 mm SQ. x 20 mm]	1/8	.06 [1.5]	.39 [10.0]
25 mm	1.772 [45.0]	.04 [1.0]	.4727/.4714 [12 (h8)]	1/8 SQ. x 1.125 [4 mm SQ. x 25 mm]	1/8	.08 [2.0]	.47 [12.0]
32 mm	2.165 [55.0]	.05 [1.2]	.625/.624 [16 (h8)]	3/16 SQ. x 1.250 [5 mm SQ. x 32 mm]	1/8	.08 [2.0]	.71 [18.0]
40 mm	2.756 [70.0]	.03 [0.8]	.750/.749 [17 (h8)]	3/16 SQ. x 1.500 [5 mm SQ. x 35 mm]	1/8	.08 [2.0]	.91 [23.0]
50 mm	3.071 [78.0]	.07 [1.8]	.875/.874 [22 (h8)]	3/16 SQ. x 1.750 [6 mm SQ. x 45 mm]	1/4	.10 [2.5]	.91 [23.0]

NOTES:
1) NUMBERS IN [ ] ARE FOR RAS5x UNITS (METRIC)
2) ALL METRIC DIMENSIONS ARE GIVEN IN MILLIMETERS - 1 mm = .03937 IN
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ENGINEERING DATA

RA SPECIFICATIONS

BORE SIZE	GEAR RACKS		PISTON DIAMETER		PISTON AREA		DISPLACEMENT	
	45°-180°	225°-270°	IN	mm	IN²	mm²	CU. IN/DEG. ROT.	CU. mm/DEG. ROT.
20 mm	1	2	.79	20	.49	314.19	.002	32.77
25 mm	1	2	.98	25	.76	490.32	.004	65.55
32 mm	1	2	1.26	32	1.25	804.19	.007	114.71
40 mm	1	2	1.57	40	1.95	1256.64	.014	229.42
50 mm	1	2	1.97	50	3.04	1963.48	.027	442.45

PRESSURE RATINGS

All Series RA Rotary Actuators have a maximum pressure rating of 150 psi or 10 bar air with breakaway pressures of 5 psi or 0.3 bar air and are for pneumatic use only.

OPERATING TEMPERATURES

Standard Series RA Rotary Actuators are recommended for use in temperatures from -20°F (-28°C) to 180°F (82°C). Consult PHD for temperatures beyond this range.

LUBRICATION

All units are permanently lubricated at assembly for service using non-lubricated air. Life can be extended by periodic lubrication of the rack and pinion using high grade bearing grease and by using lubricated air.

BACKLASH

All units have 0 degrees of backlash at ends of rotation.

ANGLE OF ROTATION

Standard angles of rotation are 45°, 90°, 135°, 180°, 225°, and 270°. Consult PHD for other rotation requirements. All units have built-in angle adjustments providing +10°, -45°.

ROTATIONAL TOLERANCE

The total rotational tolerance of the Series RA Rotary Actuator is +10°, -0° on the nominal specified rotation.

ROTATIONAL RATES

The average speed of rotation for units with no load is 180° in .05 seconds for 20 mm, 25 mm, and 32 mm bore units, 180° in .06 seconds for 40 mm bore units, and 180° in .075 seconds for 50 mm bore units.

CONTROLS

Control of pinion shaft speed is extremely important as inertia force is a function of rotational speed and distance from load to output shaft center. PHD's built-in flow controls, cushions, and shock absorbers should be considered when inertial loads are applied. See pages 8, 9, and 10 for information on Series RA Rotary Actuator controls. See pages 12, 13, and 14 for information on load stopping capacity.

BEARING LOADS TABLE

BORE SIZE	AXIAL BEARING LOAD CAPACITY		RADIAL BEARING LOAD CAPACITY		DISTANCE BETWEEN BEARINGS	
	LB	N	LB	N	IN	mm
20 mm	97	431	376	1672	1.34	34.0
25 mm	118	524	453	2015	1.61	40.9
32 mm	182	809	640	2846	1.94	49.3
40 mm	237	1054	746	3318	2.56	65.0
50 mm	325	1445	966	4296	2.90	73.6

THEORETICAL TORQUE OUTPUT

INPUT PRESSURE		BORE SIZE									
		20 mm		25 mm		32 mm		40 mm		50 mm	
PSI	BAR	IN/LB	Nm	IN/LB	Nm	IN/LB	Nm	IN/LB	Nm	IN/LB	Nm
40	2.7	3.9	.44	7.6	.85	16	1.8	31	3.5	60	6.8
50	3.4	4.9	.55	9.5	1.0	20	2.3	38	4.4	76	8.6
60	4.1	5.8	.65	11	1.2	24	2.8	46	5.2	91	10
70	4.8	6.8	.77	13	1.5	29	3.2	54	6.1	106	12
80	5.5	7.8	.88	15	1.7	33	3.7	62	7.0	121	13
90	6.2	8.8	.99	17	1.9	37	4.2	70	7.9	136	15
100	6.8	9.7	1.1	19	2.1	41	4.6	77	8.8	152	17
120	8.2	11	1.3	22	2.5	49	5.6	93	10	182	20
130	8.9	12	1.4	24	2.7	54	6.1	101	11	197	22
140	9.6	13	1.5	26	3.0	58	6.5	109	12	213	24
150	10	14	1.6	28	3.2	62	7.0	116	13	228	25

ENGINEERING DATA

ROTARY ACTUATOR WEIGHT TABLE

BORE SIZE	TYPE OF UNIT	NOMINAL ROTATION									
		45°		90°		135°		180°		225° OR 270°	
		LB	Kg	LB	Kg	LB	Kg	LB	Kg	LB	Kg
20 mm	STANDARD	1.8	.77	1.8	.77	1.8	.77	1.8	.77	2.3	1.02
	WITH SHOCK OPTION -NB	2.0	.88	2.0	.88	2.1	.89	2.1	.89	2.4	1.09
25 mm	STANDARD	2.4	1.08	2.4	1.08	2.8	1.24	2.8	1.24	3.6	1.60
	WITH SHOCK OPTION -NB	2.9	1.29	2.9	1.29	3.3	1.46	3.3	1.46	3.9	1.75
32 mm	STANDARD	4.3	1.92	4.3	1.92	4.9	2.19	4.9	2.19	6.5	2.94
	WITH SHOCK OPTION -NB	5.2	2.33	5.2	2.33	5.8	2.63	5.8	2.63	7.1	3.19
40 mm	STANDARD	7.7	3.47	7.7	3.47	8.8	3.96	8.8	3.96	11.8	5.31
	WITH SHOCK OPTION -NB	9.5	4.30	9.5	4.30	10.7	4.84	10.7	4.84	13.0	5.89
50 mm	STANDARD	11.6	5.22	11.6	5.22	12.8	5.78	12.8	5.78	17.7	8.01
	WITH SHOCK OPTION -NB	14.3	6.47	14.3	6.47	15.7	7.09	15.7	7.09	19.0	8.59

CUSHION AND OUTPUT HUB WEIGHTS

BORE SIZE	ADDER WITH CUSHION OPTION -DB		ADDER WITH HUB OPTION -Q10 OR -Q19	
	LB	Kg	LB	Kg
20 mm	.3	.13	.03	.01
25 mm	.4	.16	.03	.01
32 mm	.6	.24	.04	.02
40 mm	.8	.34	.12	.05
50 mm	1.1	.47	.23	.11

STANDARD ANGLE ADJUSTMENT

All PHD Series RA Rotary Actuators are supplied as standard with built-in adjustable angle stops. These mechanical positive stops provide an adjustment range of +10°, -45° on each nominal angle of rotation (see Table 1).

Units with rotations of 180° or less utilize adjusting screws in the top of the actuator which stop against a stop cam attached to the pinion shaft (see Illustration A). Units with rotations of 225° and 270° use angle adjustment screws located in the end caps which stop against the auxiliary lower rack (see Illustration B). When 225° or 270° units are ordered with optional shock absorbers, the shock absorbers double as the angle adjustment screws.

The ability to adjust over such a wide range eliminates the need to order special units for specific angles of rotation. The range of nominal rotations and the +10°, -45° adjustments provide a total rotation range of 0° to 280° across the Series RA Rotary Actuator line.

NOTE: Cushions are effective for approximately the last 25°-30° of rotation each direction. The cushion angle will decrease by the same amount that the rotation is reduced by the angle adjustment. Consult factory for non-standard angles of rotation if cushions are required.

TABLE 1

ROTATION ORDERED	STANDARD ADJUSTMENT RANGE
45°	0° through 55°
90°	45° through 100°
135°	90° through 145°
180°	135° through 190°
225° or 270°	180° through 280°

ILLUSTRATION A

ANGLE ADJUSTMENT SCREW

STOP CAM

ILLUSTRATION B

ANGLE ADJUSTMENT SCREW
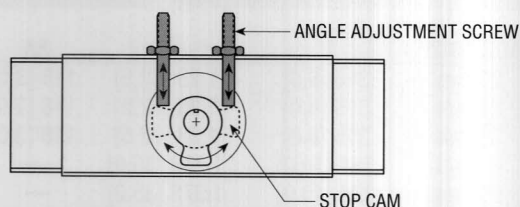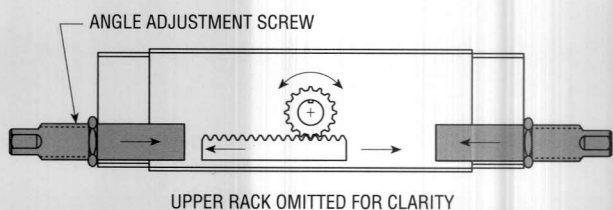
UPPER RACK OMITTED FOR CLARITY

OPTIONS

PB PORT CONTROL®
BOTH DIRECTIONS

PC PORT CONTROL®
COUNTERCLOCKWISE DIRECTION

PW PORT CONTROL®
CLOCKWISE DIRECTION

PHD Port Control® is a built-in flow control valve for controlling the speed through complete shaft rotation. The Port Control® is based on the "meter-out" principle and features an adjustable needle in a cartridge with an external check seal. The self-locking needle has micrometer threads and is adjustable under pressure. It determines the orifice size which controls the exhaust flow rate of the actuator. The check seal expands while air is exhausting from the actuator, forcing the air to exhaust past the adjustable needle. The check seal collapses to allow a free flow of incoming air. The PHD Port Control® saves space and eliminates the cost of fittings and installation for external flow control valves.

RASx20, RASx25, RASx32

RASx40 & RASx50

BORE SIZE	F	G	AA
20 mm	.394 [10.0]	.768 [19.5]	.374 [9.5]
25 mm	.394 [10.0]	.768 [19.5]	.374 [9.5]
32 mm	.394 [10.0]	.768 [19.5]	.374 [9.5]
40 mm	.472 [12.0]	.945 [24.0]	.965 [24.5]
50 mm	.472 [12.0]	.945 [24.0]	1.083 [27.5]

Numbers in [ ] are in mm.

DB CUSHION BOTH DIRECTIONS

DC CUSHION
COUNTERCLOCKWISE DIRECTION

DW CUSHION
CLOCKWISE DIRECTION

PHD Cushions allow for smooth deceleration at the end of rotation. When the cushion operates, the remaining volume of air in the actuator must exhaust past an adjustable needle, which controls the deceleration of the pinion shaft. The effective length of the cushion is approximately 25°-30° of rotation at the end of full nominal rotation. The use of angle adjustment screws to reduce the angle of rotation has a direct effect on the length of cushion engagement. Example: 5° of angle reduction on one end will reduce cushion engagement by 5° on that end of rotation. See pages 12, 13, and 14 for information on unit stopping capacity with adjustable cushions.
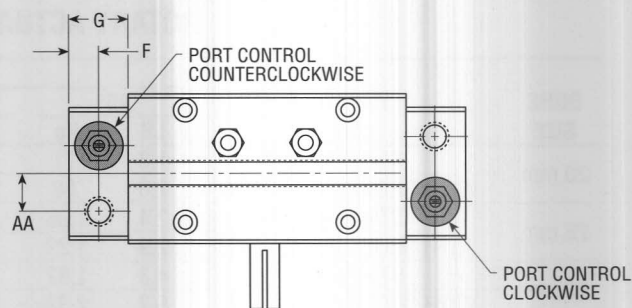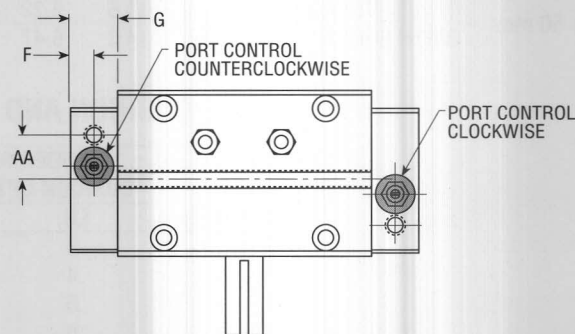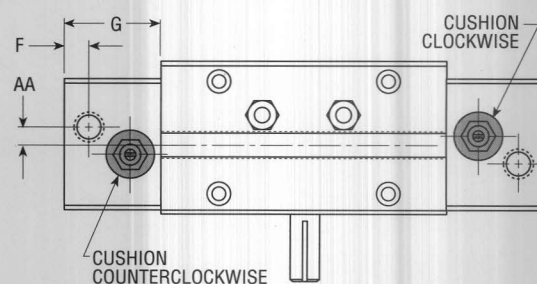
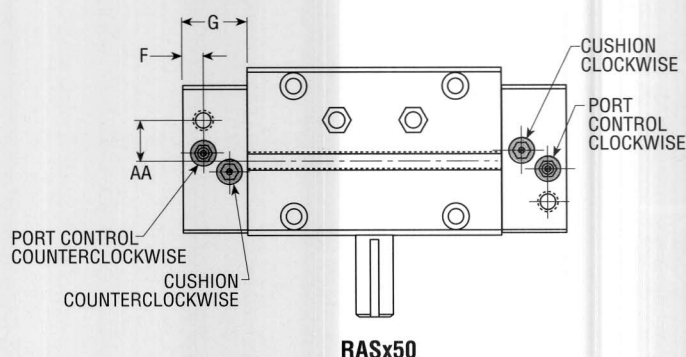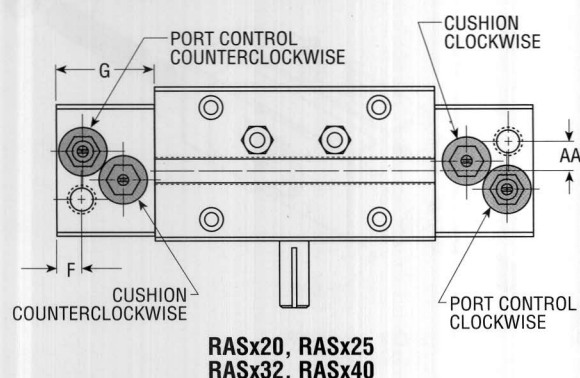| BORE SIZE	F	G	AA
20 mm	.315 [8.0]	1.28 [32.5]	.118 [3.0]
25 mm	.315 [8.0]	1.28 [32.5]	.118 [3.0]
32 mm	.315 [8.0]	1.28 [32.5]	.118 [3.0]
40 mm	.394 [10.0]	1.378 [35.0]	—
50 mm	.394 [10.0]	1.378 [35.0]	—

Numbers in [ ] are in mm.

OPTIONS

PORT CONTROL® AND CUSHION LOCATIONS

**RASx20, RASx25
RASx32, RASx40**

RASx50

BORE SIZE	F	G	AA
20 mm	.335 [8.5]	1.280 [32.5]	.374 [9.5]
25 mm	.335 [8.5]	1.280 [32.5]	.374 [9.5]
32 mm	.335 [8.5]	1.280 [32.5]	.374 [9.5]
40 mm	.394 [10.0]	1.378 [35.0]	.453 [11.5]
50 mm	.453 [11.5]	1.378 [35.0]	1.083 [27.5]

Numbers in [ ] are in mm.

E — MAGNETS FOR PHD MINIATURE HALL EFFECT SWITCHES

This option equips the rotary actuator with magnets on the rack for use with PHD Series 5360 Miniature Hall Effect Switches. These switches mount easily to the actuator using the "T" slot in the top of the body.

PART NO.	COLOR	DESCRIPTION
53603-1-02	Yellow	NPN (Sink) 4.5-24 VDC, 2 m cable
53604-1-02	Red	PNP (Source) 4.5-24 VDC, 2 m cable
53623-1	Yellow	NPN (Sink) 4.5-24 VDC, Quick Connect
53624-1	Red	PNP (Source) 4.5-24 VDC, Quick Connect

M — MAGNETS FOR PHD MINIATURE REED SWITCHES

This option equips the rotary actuator with magnets on the rack for use with PHD Series 5360 Miniature Reed Switches. These switches mount easily to the actuator using the "T" slot in the top of the body.

PART NO.	COLOR	DESCRIPTION
53602-2-02	White	Sink or Source Type 4.5-24 VDC, 2 m cable
53601-1-02	Blue	AC Type 65-120 VAC, 2 m cable
53609-2-02	Green	AC Type 110-120 VAC with Current Limit, 2 m cable
53622-2	White	Sink or Source Type VDC, Quick Connect
53621-1	Blue	AC Type 65-120 VAC, Quick Connect
53629-2	Green	AC Type 110-120 VAC, Quick Connect with Current Limit

FLATS OF STROKE ADJUSTMENT NUTS MUST BE ORIENTED AS SHOWN

SWITCHES MUST BE ORIENTED AS SHOWN FOR PROPER SENSING

.317 [8 mm]
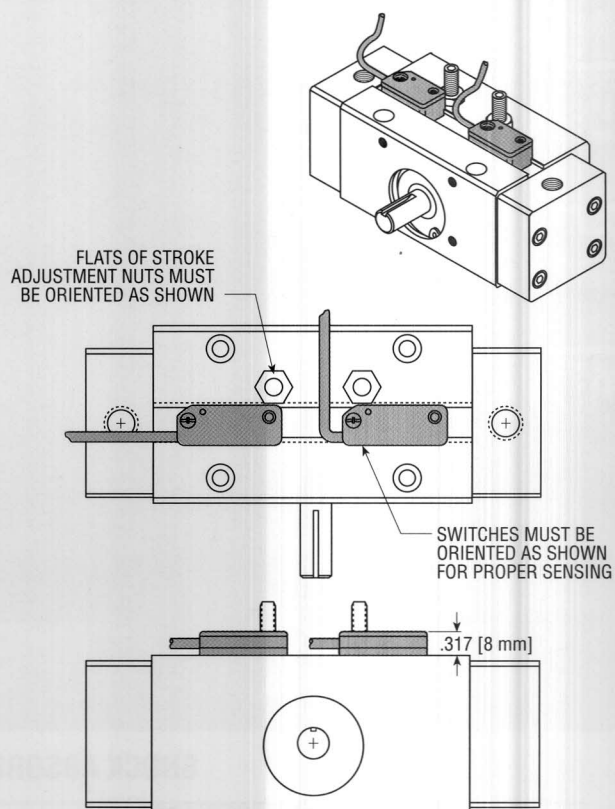
PHD Series 5360 Miniature Hall Effect and Reed Switches are designed specifically to provide an input signal to various types of programmable controllers or logic systems. See PHD's complete catalog for information on the Series 5360 Miniature Switches.

NOTE: When mounting miniature switches on the 20 mm and 25 mm bore units with rotations up to 180°, see the drawing above. Minimum rotation on a 20 mm bore unit with two switches is 45°.

OPTIONS

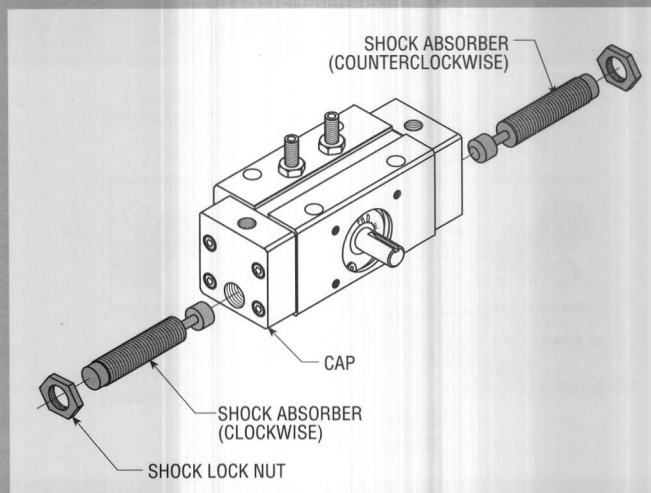**NB** SHOCK ABSORBER INSTALLED BOTH DIRECTIONS

NC SHOCK ABSORBER INSTALLED COUNTERCLOCKWISE DIRECTION

NW SHOCK ABSORBER INSTALLED CLOCKWISE DIRECTION

The hydraulic shock absorber options are designed for the maximum in deceleration control and rotational stopping ability. The -NB, -NC, and -NW options provide the rotary actuator with the hydraulic shock absorber installed in the appropriate location(s). See pages 12, 13, and 14 for details on unit stopping capacity with built-in shock absorbers.

NOTE: The shock absorber doubles as the rotation adjustment on units with rotations greater than 180°.

GS SHOCK ABSORBER READY BOTH DIRECTIONS

GT SHOCK ABSORBER READY COUNTERCLOCKWISE DIRECTION

GU SHOCK ABSORBER READY CLOCKWISE DIRECTION

The -GS, -GT, and -GU options should only be used if the shock absorber(s) is to be supplied separately from the rotary actuator. These options provide a unit that has provisions for installing hydraulic shock absorbers but have no shock absorbers included. See pages 12, 13, and 14 for details on unit stopping capacity with built-in shock absorbers.
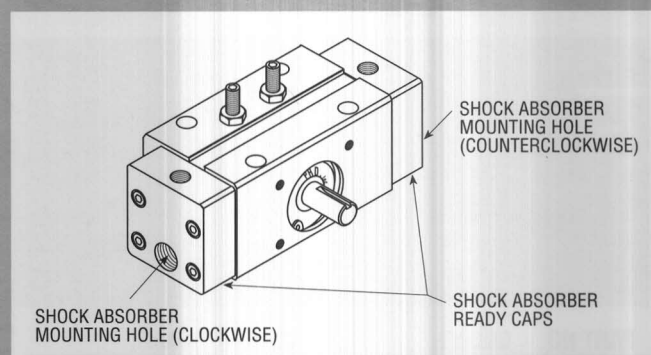
NOTE: The shock absorber doubles as the rotation adjustment on units with rotations greater than 180°. Shock absorbers **must** be installed in the rotary actuator prior to operating the unit. Operation of units with shock absorber ready options without installed shocks can damage the units and void any and all warranties. Only the Ace Brand Shock Absorbers listed should be used in Series RA Rotary Actuators. The use of any other shock absorbers will affect actuator performance and life expectancy.

SHOCK ABSORBER SPECIFICATIONS

| BORE SIZE	PHD SHOCK ABSORBER NUMBER	ACE SHOCK ABSORBER NUMBER	THREAD TYPE	STROKE		SHOCK ABSORBER WEIGHT		KINETIC ENERGY LOAD	
				IN	mm	LB	Kg	IN-LB	Nm
20 mm	56714-01	MC 75M-T .242-1876	M12 x 1	.13	3.30	.09	.04	1.1	.12
25 mm	56714-02	MC 150M-T .302-1877	M14 x 1.5	.19	4.83	.12	.54	3.1	.35
32 mm	56714-03	MC 225M-T .239-1878	M20 x 1.5	.25	6.35	.34	.15	5.0	.57
40 mm	56714-04	MC 600M-T .685-1879	M25 x 1.5	.31	7.87	.57	.26	15.0	1.70
50 mm	56714-05	MC 600M-T .608-1880	M25 x 1.5	.31	7.87	.57	.26	29.5	3.33

OPTIONS

Q10 OUTPUT HUB

This option provides an output hub in place of the conventional pinion shaft output. The hub includes four thru holes counterbored from one surface and threaded from the other, allowing easy mounting of fixturing, tooling, or other actuators requiring a flat surface area. The hub is manufactured from alloy aluminum and comes assembled to a specially designed low profile pinion shaft. The hub can be removed to allow custom machining for specific mounting needs. The hub hole pattern can be oriented in 22.5° increments. Separate hubs are available in a kit complete with all hardware. See chart below.

Q19 OUTPUT HUB WITH HOLLOW PINION SHAFT

This option provides an output hub with a hollow pinion shaft in place of the standard pinion shaft output. The hub has four thru holes counterbored from one surface and threaded from the other, allowing easy mounting of fixturing, tooling, or other actuators requiring a flat surface area. The pinion shaft is hollow for feeding pneumatic or electrical lines from the back of the rotary actuator to the output hub. The hub is manufactured from alloy aluminum and comes assembled to a specially designed low profile pinion shaft. The hub can be removed to allow custom machining for specific mounting needs. It can also be rotated in 22.5° rotations. Kinetic energy ratings are reduced by 10% for this option.

NOTE: Available on 32 mm, 40 mm, and 50 mm units.
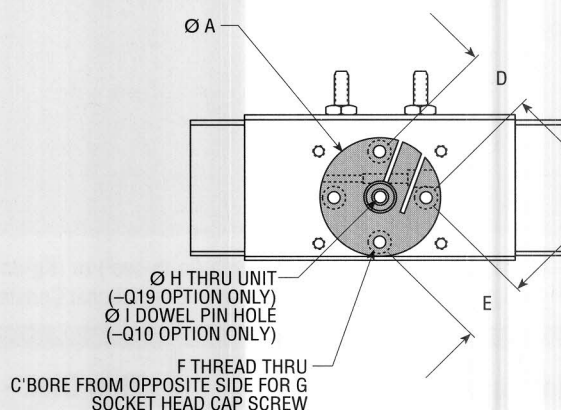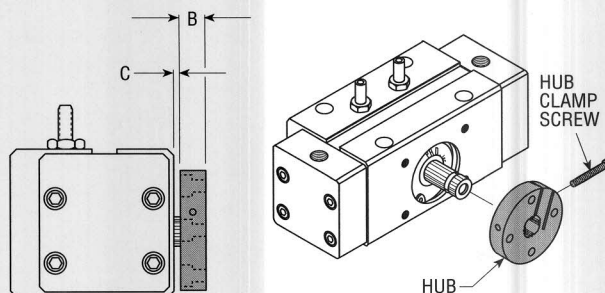
BORE SIZE	A	B	C	D	E	F	G	H	I
20 mm	1.535 [39.0]	.374 [9.5]	.100 [2.5]	.787 [20.0]	.787 [20.0]	8-32 [M4 x 0.7]	#4 [M3]	—	.1264 x .25 DP [3.21 x 6.4 DP]
25 mm	1.772 [45.0]	.374 [9.5]	.100 [2.5]	.945 [24.0]	.945 [24.0]	10-32 [M5 x 0.8]	#6 [M4]	—	.1264 x .25 DP [3.21 x 6.4 DP]
32 mm	2.165 [55.0]	.492 [12.5]	.100 [2.5]	1.102 [28.0]	1.102 [28.0]	1/4-28 [M6 x 1.0]	#10 [M4]	.276 [7.0]	.2514 x .50 DP [6.39 x 12.7 DP]
40 mm	2.717 [69.0]	.492 [12.5]	.100 [2.5]	1.398 [35.5]	1.398 [35.5]	1/4-28 [M8 x 1.25]	#10 [M6]	.315 [8.0]	.2514 x .50 DP [6.39 x 12.7 DP]
50 mm	2.953 [75.0]	.748 [19.0]	.100 [2.5]	1.575 [40.0]	1.575 [40.0]	7/16-20 [M10 x 1.5]	3/8 [M8]	.354 [9.0]	.2514 x .50 DP [6.39 x 12.7 DP]

Numbers in [ ] are in mm.

HUB INERTIA TABLE

BORE SIZE	Jm TOTAL IN-LB-SEC²	Jm TOTAL Kg-m²	HUB WEIGHT	
			LB	Kg
20 mm	.000043831	4.96×10^{-6}	.06	.03
25 mm	.000085146	9.63×10^{-6}	.08	.04
32 mm	.000225389	2.55×10^{-5}	.14	.06
40 mm	.000731212	8.27×10^{-5}	.30	.14
50 mm	.001230561	1.39×10^{-4}	.42	.19

Rotational mass moment of inertia is based on hub plus mounting screw.

HUB REPLACEMENT KITS

BORE SIZE	KIT NUMBER	
	ENGLISH	METRIC
20 mm	57651-2721-1	57658-2771-1
25 mm	57652-2731-1	57659-2781-1
32 mm	57653-2741-1	57660-2791-1
40 mm	57654-2751-1	57661-2801-1
50 mm	57655-2761-1	57662-2811-1

ROTARY ACTUATOR SELECTION

Calculating the stopping capacity of the Series RA Rotary Actuator can be done in either of two methods. The first uses the Kinetic Energy (KE) Ratings Graphs (see page 13) and covers most applications. The second method is for those applications that fall at the very ends or outside of the graphs. This method requires the determining of the kinetic energy (KE) for the application and comparing the required KE to the KE performance ratings for each rotary actuator.

METHOD 1
To calculate stopping capacity using the KE Ratings Graphs:

1) Determine Mass Moment of Inertia:
   Select the illustration from the application types below that most resembles your specific application. Using the appropriate application equation, calculate the mass moment of inertia (Jm).
2) Determine Rotational Velocity:
   Review your application and determine the required velocity in degrees per second (required cycle time).
3) Using Jm and velocity, use the Kinetic Energy Ratings Graphs to choose the correct size of rotary actuator and whether your application requires cushions or shock absorbers.

NOTE: When using the -Q10 or -Q19 options, the mass moment of inertia (Jm) of the hub has been calculated. Add the application Jm to the Hub Jm to determine kinetic energy. See the Hub Inertia Table on the bottom of page 11. The -Q19 hubbed hollow pinion option has a 10% reduction in kinetic energy.

METHOD 2
To calculate stopping capacity by determining the kinetic energy of the application:

1) Determine Mass Moment of Inertia:
   Select the illustration from the application types below that most resembles your specific application. Using the appropriate application equation, calculate the mass moment of inertia (Jm).
2) Determine Rotational Velocity:
   Use the velocity equation on page 13 to determine the velocity in rad/sec (w). Use peak velocity at the end of rotation for determining w.
3) Use the kinetic energy equation on page 13 to determine KE. Compare the KE of the application to the KE of the various rotary actuators in the Kinetic Energy Table on page 13. The actuator's KE rating must be equal to or greater than the KE of the application.

Jm = Rotational Mass Moment of Inertia (in-lb-sec^2) or (Kg-cm-sec^2) (Dependent on physical size of object and weight)
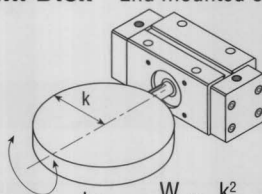W = Weight of Load (lb) or (Kg)   g = Gravitational Constant = 386.4 in/sec^2 or 980 cm/sec^2 k = Radius of Gyration (in) or (cm)
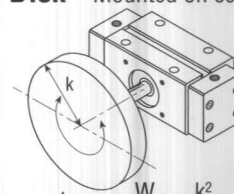
Point Load
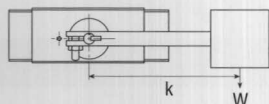
$$Jm = \frac{W}{g} \times k^2$$

Thin Disk - End mounted on center

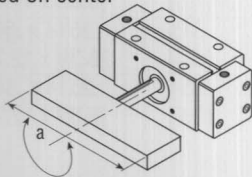$$Jm = \frac{W}{g} \times \frac{k^2}{4}$$

Thin Disk - Mounted on center

$$Jm = \frac{W}{g} \times \frac{k^2}{2}$$
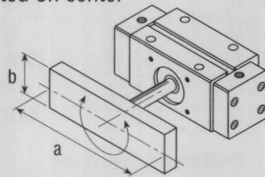
Rectangular Thin Plate
Mounted on center

$$Jm = \frac{W}{g} \times \frac{a^2}{12}$$
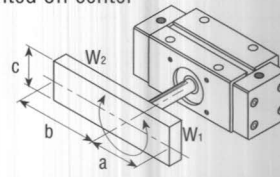
Rectangular Thin Plate
Mounted on center
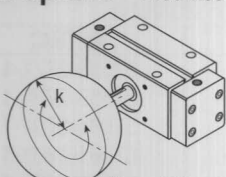
$$Jm = \frac{W}{g} \times \frac{a^2 + b^2}{12}$$

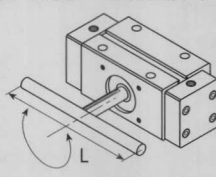### Rectangular Thin Plate
Mounted off center

$$Jm = \frac{W_1}{g} \times \frac{4a^2 + c^2}{12} + \frac{W_2}{g} \times \frac{4b^2 + c^2}{12}$$
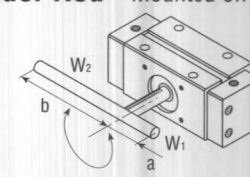
Solid Sphere - Mounted on center

$$Jm = \frac{2}{5} \times \frac{W}{g} \times k^2$$

Slender Rod - Mounted on center

$$Jm = \frac{W}{g} \times \frac{L^2}{12}$$

Slender Rod - Mounted off center

$$Jm = \frac{W_1}{g} \times \frac{a^2}{3} + \frac{W_2}{g} \times \frac{b^2}{3}$$

ROTARY ACTUATOR SELECTION

ROTATIONAL VELOCITY FORMULA

w = Peak Velocity (rad/sec)

$$w = \frac{rad.}{sec.} = \frac{deg.}{\dfrac{57.296}{rot.\ time}}$$

KINETIC ENERGY BASIC FORMULA

$$KE = 1/2\ Jm\ w^2$$

KINETIC ENERGY TABLE
FOR METHOD 2

BORE SIZE	KE MAX. PLAIN UNIT		KE MAX. WITH CUSHION		KE MAX. WITH SHOCK ABSORBER	
	IN-LB	Nm	IN-LB	Nm	IN-LB	Nm
20 mm	.21	.0237	.75	.0848	1.10	.1243
25 mm	.46	.0519	1.70	.1921	3.10	.3503
32 mm	.96	.1085	3.60	.4068	7.10	.8023
40 mm	1.74	.1966	6.75	.7628	15.0	1.695
50 mm	2.13	.2407	8.81	.9955	29.5	3.334

20 mm KINETIC ENERGY RATINGS

ROTATION VELOCITY (deg/sec)

Jm - MASS MOMENT OF INERTIA in-lb-sec² (Kg-cm-sec²)

25 mm KINETIC ENERGY RATINGS

ROTATION VELOCITY (deg/sec)

Jm - MASS MOMENT OF INERTIA in-lb-sec² (Kg-cm-sec²)

32 mm KINETIC ENERGY RATINGS

ROTATION VELOCITY (deg/sec)

Jm - MASS MOMENT OF INERTIA in-lb-sec² (Kg-cm-sec²)

40 mm KINETIC ENERGY RATINGS

ROTATION VELOCITY (deg/sec)

Jm - MASS MOMENT OF INERTIA in-lb-sec² (Kg-cm-sec²)

50 mm KINETIC ENERGY RATINGS

ROTATION VELOCITY (deg/sec)

Jm - MASS MOMENT OF INERTIA in-lb-sec² (Kg-cm-sec²)
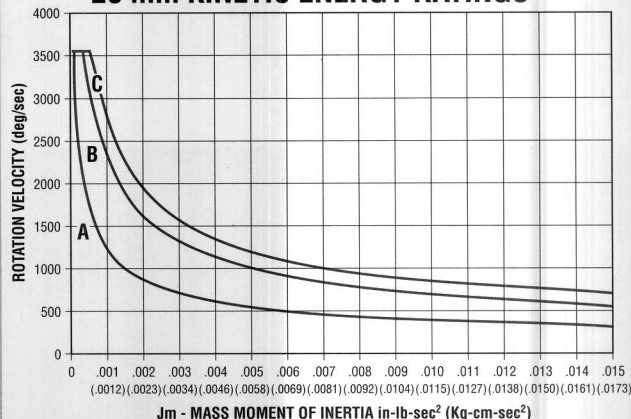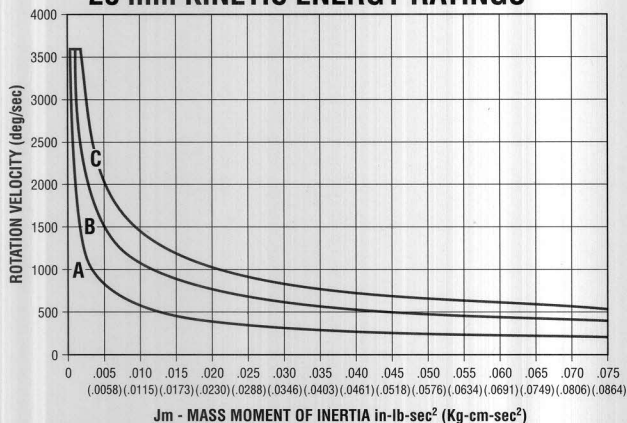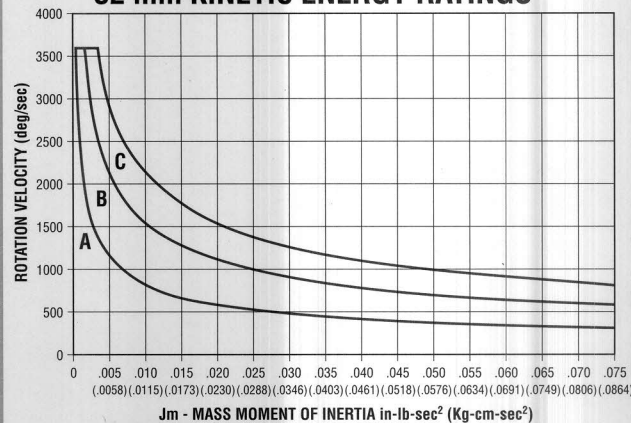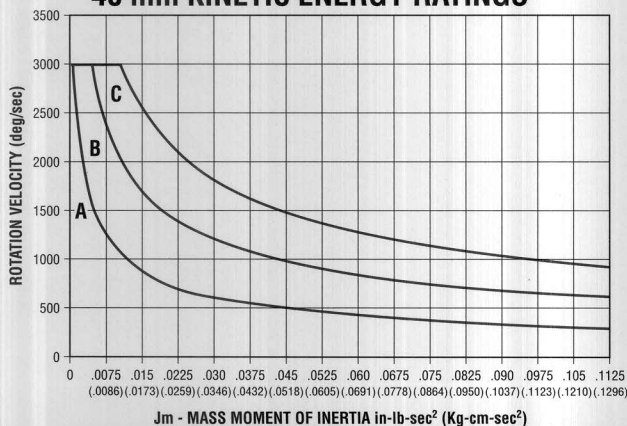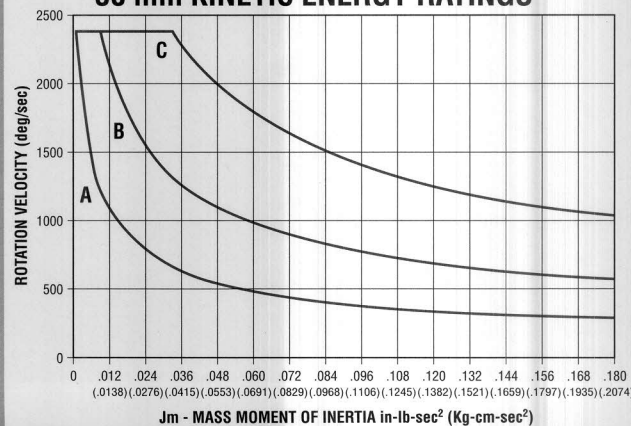
APPLICATION EXAMPLE

Application Data

Rotation Time = 180°/.10 sec.
Load = Aluminum Disk Weight of .236 lb.

Kinetic Energy = $1/2$ Jm w^2

Jm = Mass Moment of Inertia
w^2 = Rotational Velocity (avg./peak)
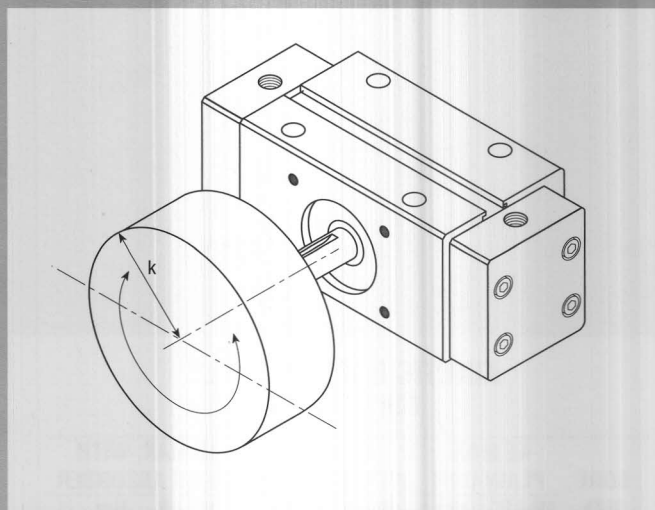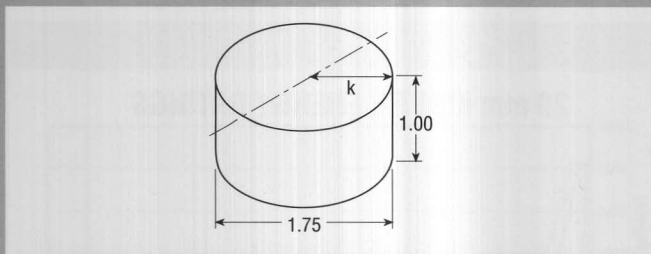KE = Kinetic Energy

1) Find Jm:

For disk $Jm = \dfrac{W}{g} \times \dfrac{k^2}{2} = \dfrac{.236 \text{ lb.}}{386.4} \times \dfrac{.875^2}{2} =$

$\qquad$ Jm = .000234 in-lb-sec^2

2) Determine Rotational Velocity:

rad/sec = w

$w = \dfrac{\text{rad.}}{\text{sec.}} = \dfrac{\dfrac{\text{deg.}}{57.296}}{\text{rot. time}} = \dfrac{\dfrac{180°}{57.296}}{.10 \text{ sec.}} =$

w = 31.42 rad/sec

3) Determine KE:

KE = $1/2$ Jm w^2

KE = (1/2) (.000234) (31.42^2) = .116 in-lb

A 20 mm bore rotary actuator is suitable for this application.

PARTS LIST

PORT CONTROL ASSEMBLY
CUSHION ASSEMBLY

225°-270°

45°-180°
90°
45°
135°
180°

KEYED PINION (STD)

HUBBED PINION (–Q10)
HUBBED HOLLOW PINION (–Q19)

225°-270°
45°-180°

SHOCK OPTION

CUSHION ASSEMBLY
PORT CONTROL ASSEMBLY

CUSHION & PORT CONTROL CAP
CUSHION CAP
PORT CONTROL CAP
PLAIN CAP

225°-270°

SHOCK OPTION

225°-270° STANDARD AND SHOCK OPTION, 45°-180° SHOCK OPTION ONLY

HUB OPTION (-Q10 & -Q19) SEE PAGE 11.
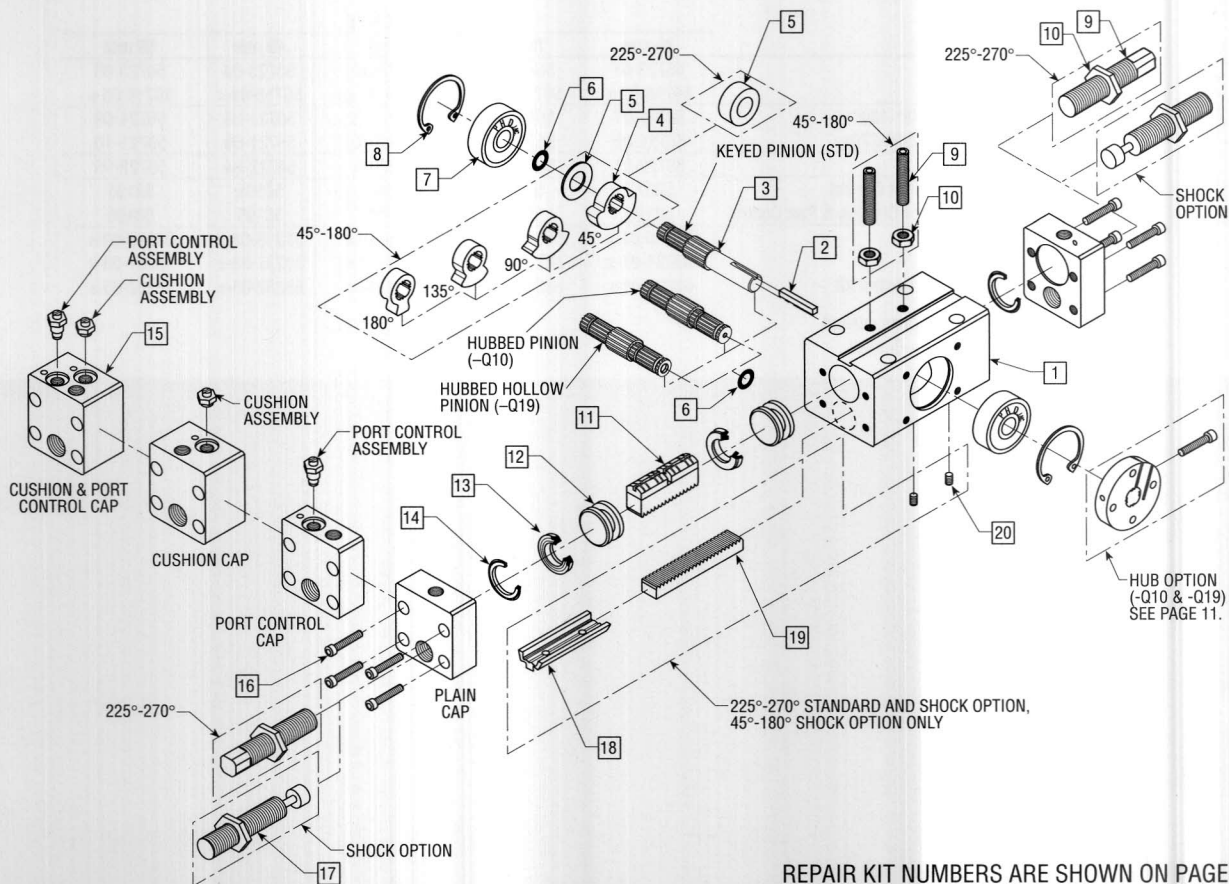
KEY	DESCRIPTION	BORE SIZE				
		20 mm	25 mm	32 mm	40 mm	50 mm
1	Body	SPECIFY KEY NO., PART DESCRIPTION, AND FULL UNIT DESCRIPTION				
2	Key	57593-01-001	6253-016	6253-020	6253-018	6253-019
	Metric Key	56717-001	56717-002	56717-003	56717-004	56717-005
3	Standard Keyed Pinion	55417	55418	55419	55420	55421
	Metric Standard Keyed Pinion	56707	56708	56709	56710	56711
	Hubbed Pinion, -Q10	55449	55450	55451	55452	56526
	Metric Hubbed Pinion, -Q10	55449	55450	55451	55452	56526
	Hollow Pinion, -Q19	—	—	58187	58188	58189
	Metric Hollow Pinion, -Q19	—	—	58187	58188	58189
4	Stop Cam, 45° Rotation	56599	56600	56601	56602	56603
	Stop Cam, 90° Rotation	56607	56608	56609	56610	56611
	Stop Cam, 135° Rotation	56615	56616	56617	56618	56619
	Stop Cam, 180° Rotation	56623	56624	56625	56626	56627
5	Spacer, 45°-180°	56378	56379	56380	56381	56382
	Spacer, 225°-270°	56386	56387	56388	56389	56390
6	Pinion Shaft O-ring	SOLD AS PART OF SEAL KIT				
7	Bearing	SOLD AS PART OF BEARING KIT				
8	Retaining Ring	SOLD AS PART OF BEARING KIT				
9	Angle Adjustment Screw	SOLD AS PART OF ANGLE ADJUSTMENT KIT				
10	Angle Adjustment Nut	SOLD AS PART OF ANGLE ADJUSTMENT KIT				
11	Upper Rack Assembly	SPECIFY KEY NO., PART DESCRIPTION, AND FULL UNIT DESCRIPTION				
12	Piston	SOLD AS PART OF BEARING KIT				
13	Piston Seal	SOLD AS PART OF SEAL KIT				
14	Cap Seal	SOLD AS PART OF SEAL KIT				
15	Cap Assembly	SPECIFY KEY NO., PART DESCRIPTION, AND FULL UNIT DESCRIPTION				
16	Mounting Screw	SOLD AS PART OF MOUNTING KIT				
17	Shock Absorber	SOLD AS PART OF SHOCK KIT				
18	Lower Rack Shoe	56354	56355	56356	56357	56358
19	Lower Rack, 45°-90°	56337-1	56338-1	56339-1	56340-1	56341-1
	Lower Rack, 135°-180°	56337-2	56338-2	56339-2	56340-2	56341-2
	Lower Rack, 225°-270°	56337-3	56338-3	56339-3	56340-3	56341-3
20	Socket Head Set Screw, Shoe	17424-009	17424-064	17424-065	17424-066	17424-066

REPAIR KITS

QTY.	DESCRIPTION	BORE SIZE				
		20 mm	25 mm	32 mm	40 mm	50 mm
1	Bearing Kit	56723-01	56723-02	56723-03	56723-04	56723-05
1	Seal Kit	56718-01-x	56718-02-x	56718-03-x	56718-04-x	56718-05-x
1	Angle Adjustment Kit, 45°-180°	56721-01	56721-02	56721-03	56721-04	56721-05
	Angle Adjustment Kit, 225°-270°	56721-06	56721-07	56721-08	56721-09	56721-10
1*	Shock Kit	56722-01	56722-02	56722-03	56722-04	56722-05
1*	Mounting Kit, Plain or Port Control	53377	53380	53386	58195	58195
	Mounting Kit, Cushion or Cushion & Port Control	58193	58194	58194	58196	58196
1*	Port Control Assembly	58316-01-x	58316-01-x	58316-01-x	58316-02-x	58316-02-x
1*	Cushion Needle Kit	58231-01-x	58231-02-x	58231-02-x	58231-03-x	58231-03-x
1*	Cushion Needle & Port Control Kit	58232-01-x	58232-02-x	58232-02-x	58232-03-x	58232-03-x

*One kit required for each direction desired.
Seal Composition: xxxxx-xx-1 = Buna-N